

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>H04R 25/00</b>	<b>A1</b>	(11) International Publication Number: <b>WO 98/49868</b>
		(43) International Publication Date: 5 November 1998 (05.11.98)

(21) International Application Number: PCT/US98/08729  
(22) International Filing Date: 30 April 1998 (30.04.98)  
(30) Priority Data:  
08/846,637 30 April 1997 (30.04.97) US  
(71) Applicant: AMERICAN TECHNOLOGY CORPORATION  
[US/US]; 12725 Stowe Drive, Poway, CA 92064 (US).  
(72) Inventor: NORRIS, Elwood, G.; 13824 San Sebastian Way,  
Poway, CA 92064 (US).  
(74) Agents: NORTH, Vaughn, W. et al.; Thorpe, North & Western,  
LLP, P.O. Box 1219, Sandy, UT 84091-1219 (US).

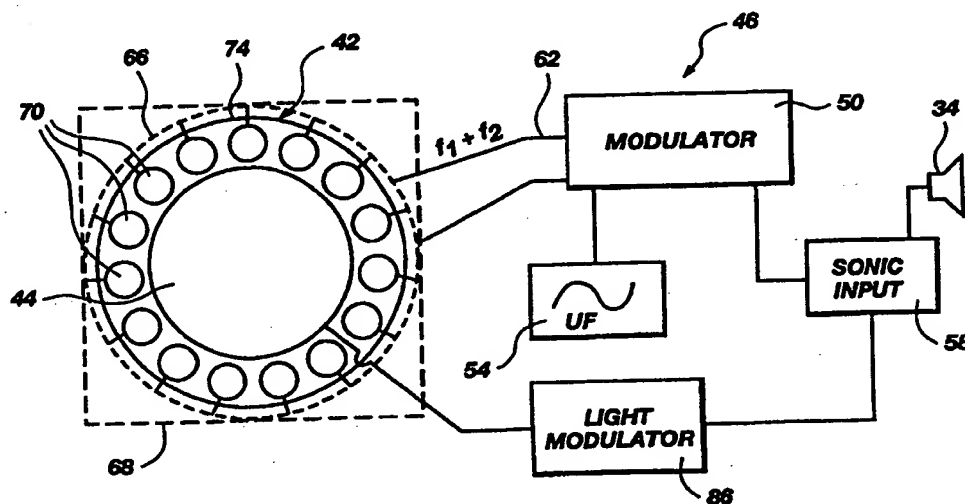
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR,  
BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE,  
GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ,  
LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW,  
MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ,  
TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent  
(GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent  
(AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent  
(AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT,  
LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI,  
CM, GA, GN, ML, MR, NE, SN, TD, TG).

**Published**

*With international search report.*

*Before the expiration of the time limit for amending the  
claims and to be republished in the event of the receipt of  
amendments.*

(54) Title: LIGHT ENHANCED BULLHORN



(57) Abstract

A sound projection device (10) for use in speaking to one or more specific persons on a selective basis, the device including a housing having a directional aspect for aiming the housing at a target area, a gripping handle (14) coupled to the housing to enable the device to be held in a user's hand, and a parametric speaker (42) coupled to a front end of the housing for indirectly generating at least one new sonic frequency from at least two ultrasonic frequencies of different value. The housing includes a luminating source (44) having a directional orientation substantially aligned with the directional aspect of the housing. The combination of light and directional sound source enables the user to visually identify the target area before transmitting the sonic frequency to the target.

BEST AVAILABLE COPY

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon	KR	Republic of Korea	PL	Poland		
CN	China	KZ	Kazakstan	PT	Portugal		
CU	Cuba	LC	Saint Lucia	RO	Romania		
CZ	Czech Republic	LI	Liechtenstein	RU	Russian Federation		
DE	Germany	LK	Sri Lanka	SD	Sudan		
DK	Denmark	LR	Liberia	SE	Sweden		
EE	Estonia			SG	Singapore		

**LIGHT ENHANCED BULLHORN**  
**BACKGROUND OF THE INVENTION**

**1. Field of the Invention**

5 This invention pertains to handheld sound projection devices. More particularly, the present invention relates to a device and method for enhancing a bullhorn with directionally projected light in combination with a directional parametric speaker.

**2. State of the art**

10 Outdoor sound projection and amplification is typically accomplished with a megaphone or bullhorn device capable of extending the distance of speech projection. Such focusing devices are necessary because the human voice quickly dissipates in an open  
15 environment. This arises in part from the fact that the human speech mechanism is extremely effective in omnidirectional sound projection. The complex resonant structure of the skull, mask of the face and vocal column are amazingly proficient in radiating  
20 sound in a generally omnidirection manner.

A megaphone operates to more effectively match the interface between an open environment and the mouth of the speaker. By channeling the sound through an expanding cone, the compression waves that must  
25 carry the sound are restricted in path and provided with an enlarging planar wave front diameter. By the time the wave front is enlarged to the opening size of the megaphone, a strong directional element is achieved, enabling a projection area of an enlarging  
30 wedge, rather than the conventional omnidirectional propagation pattern.

Despite the increased distance range of the megaphone, an unaided voice is quickly attenuated in proportion to the square of the distance. A bullhorn  
35 complements the megaphone structure with electronic voice amplification. By boosting the amplitude of the voice with a conventional amplifier circuit, a significantly extended range of hearing is achieved. Nevertheless, the pattern of propagation is still very

divergent once the sound waves clear the horn structure. This results in a general broadcast to the surrounding area, without ability to limit the listening audience. The inconvenience of general dissemination of the amplified voice communication has become accepted as an inherent limitation of a bullhorn or similar sound projection system. For example, a police helicopter equipped with a PA system can broadcast emergency messages; however, they are broadcast generally rather than being directable to a specific target area. At night, such messages may alarm or even awaken persons who need not be involved. Other messages generally broadcast can create confusion where people listen who have no interest or knowledge of the matter communicated.

A more recent technology involving directional sound has developed as part of an attempt to reproduce sound without use of a moving diaphragm such as is applied in a conventional bullhorn. This second sound propagation approach includes technologies embodied in parametric speakers, acoustic heterodyning, beat frequency interference and other forms of modulation of multiple frequencies to generate a new frequency.

In theory, sound is developed by the interaction in air (as a nonlinear medium) of two ultrasonic frequencies whose difference in value falls within the audio range. Ideally, resulting compression waves would be projected within the air as a nonlinear medium, and would be heard as pure sound. An interesting property of parametric sound generation is enhanced directionality. Despite significant publications on ideal theory, however, general production of sound for practical applications has alluded the industry for over 100 years. Specifically, a basic parametric or heterodyne speaker has not been developed which can be applied in general

applications in a manner such as conventional speaker systems.

A brief history of development of the theoretical parametric speaker array is provided in "Parametric  
5 Loudspeaker--Characteristics of Acoustic Field and  
Suitable Modulation of Carrier Ultrasound", Aoki,  
Kamadura and Kumamoto, Electronics and Communications  
in Japan, Part 3, Vol. 74, No.9 (March 1991).

Although technical components and the theory of sound  
10 generation from a difference signal between two  
interfering ultrasonic frequencies is described, the  
practical realization of a commercial sound system was  
apparently unsuccessful. Note that this weakness in  
the prior art remains despite the assembly of a  
15 parametric speaker array consisting of as many as 1410  
piezoelectric transducers yielding a speaker diameter  
of 42 cm. Virtually all prior research in the field  
of parametric sound has been based on the use of  
conventional ultrasonic transducers, typically of  
20 bimorph character.

U.S. Patent No. 5,357,578 issued to Taniishi in  
October of 1994 introduced alternative solutions to  
the dilemma of developing a workable parametric  
speaker system. Hereagain, the proposed device  
25 comprises a transducer which radiates the dual  
ultrasonic frequencies to generate the desired audio  
difference signal. However, this time the dual-  
frequency, ultrasonic signal is propagated from a gel  
medium on the face of the transducer. This medium 20  
30 "serves as a virtual acoustic source that produces the  
difference tone 23 whose frequency corresponds to the  
difference between frequencies  $f_1$  and  $f_2$ ." Col 4,  
lines 54 - 60. In other words, this 1994 reference  
abandons direct generation of the difference audio  
35 signal in air from the face of the transducer, and  
depends upon the nonlinearity of a gel medium to  
produce sound. This abrupt shift from transducer/air

interface to proposed use of a gel medium reinforces the perception of apparent inoperativeness of prior art disclosures, at least for practical speaker applications.

5           Therefore, although the parametric speaker has created interest, it has seemingly been restricted to scientific curiosity. The development of practical applications and products has been very limited. The efficiency of such systems has apparently not been  
10       adequate to suggest its utility in applications in combination with a megaphone or bullhorn.

#### OBJECTS AND SUMMARY OF THE INVENTION

          It is an object of the present invention to provide a method and apparatus for indirectly emitting  
15       new sonic and subsonic waves as part of a handheld amplification system with greatly enhanced directional properties.

          It is another object to adapt parametric sound using interference between at least two ultrasonic  
20       signals having different frequencies to develop a narrow beam of a new sonic or subsonic wave which can be focused on a single individual as part of a group of persons.

          It is still another object to provide a bullhorn  
25       type device which develops a substantially uniform wave front across a broad ultrasonic emitter surface which has a narrow pattern of divergence.

          A still further object of this invention is to provide a parametric bullhorn device which includes a  
30       directional light source in common directional alignment with a projected sound beam.

          It is an object of the present intention to provide a bullhorn device with highly directional sound and a target identification means for confirming  
35       accurate engagement with a selected listener.

          Another object of the present invention is to enable target identification with a projected light

from the bullhorn to visually confirm when the selected listener has been accurately engaged.

These and other objects are realized in a voice projecting device which comprises a housing having a configuration which supplies a directional orientation such as with a horn incorporating a parametric speaker array. The parametric speaker generates at least one new sonic frequency from at least two ultrasonic frequencies of different value, and projects them directionally toward the targeted area. The speaker comprises i) an ultrasonic frequency generator; ii) a sonic frequency generator; iii) modulating means coupled to the ultrasonic frequency generator and the sonic frequency generator for producing the at least two ultrasonic frequencies of different value; and iv) at least one ultrasonic frequency emitter coupled to the modulating means and aligned for transmission with the directional orientation of the housing for propagating the at least two ultrasonic frequencies and concurrently generating the new sonic frequency with directional sound transmission orientation toward the target. An actuating mechanism is coupled to the housing for activating the parametric speaker means to generate the new sonic frequency. A light source may also be attached to the housing for providing visual targeting where the parametric speaker and light source are in common target alignment.

Other objects, features and benefits will be apparent to those skilled in the art, based on the following detailed description, in combination with the accompanying drawings.

#### DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates one embodiment of a voice projecting device.

Figure 2 depicts the subject device in operation toward a selected person as part of a crowd.

Figure 3 illustrates supporting circuitry and power source shown coupled in block diagram.

Figure 4 shows an alternate embodiment of the present invention.

5     **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

Figure 1 illustrates one embodiment of a voice projection system similar to a bullhorn. It will be apparent that this specific structure is intended to represent many different types of projection devices  
10    such as PA systems, megaphones, etc., particularly where a directional orientation in a narrow beam is desired.

The preferred embodiment comprises a bullhorn 10 which includes a handle 14, horn 18 and primary body  
15    22. The handle 14 can be any structure which enables the user to support the bullhorn 10 in a directional position. The primary body 22 also operates as a housing for containment of the operating mechanisms, circuitry and battery power. In addition, the  
20    bullhorn 10 may include a user speaker 30, a microphone 34, a control pad 38, a trigger 40, a focal length adjustor 41, and a parametric speaker array 42 for directionally transmitting the sound.

In the preferred embodiment, the user speaker 30  
25    takes the form of either an ear jack, ultrasonic transducer or a simple audio speaker. The purpose of the speaker is to allow the user of the bullhorn 10 to hear the sounds that the bullhorn sends to a selected target 43 (see Figure 2). Otherwise, the transmitted  
30    sound is so directional in an outdoor environment that it would essentially be undetected by the user. The microphone 34 is actuated by audio signals from the user in proximity of the bullhorn 10.

Although, as shown in Figure 2, the user may  
35    desire to send personal voice messages to the target 43, the user may also desire to remain anonymous and otherwise undetectable by sending distorted voice



messages. The control panel 38 allows the user to select distortion mode and pre-recorded messages, as well as other modes of operation for the bullhorn 10. For example, the control panel 38 could be used to

5   disable the microphone 34 or to select different bullhorn operations, e.g., a sound-only system, a light-only mode, a combined light and sound transmission, sound output with modulated light output, active sound with microphone, sound with pre-

10   recorded messages, or any other combination which implements principles of the present invention.

The trigger 40 is shown in both solid and hidden lines to indicate that the trigger has multiple positions, i.e., a rest position 40A, an intermediate

15   position 40B, and an engaged position 40C. In the preferred embodiment, the rest position 40A is used when the bullhorn 10 is not in use. The intermediate position 40B partially engages the bullhorn 10 by engaging a light source 44 but not the parametric

20   speaker 42. This light source 44 is controlled by the focal length adjustor 41 so that a beam of light may be directed to the target 43. If the control panel 38 is so programmed, the engaged position 40C of the trigger 40 is used to engage the light source 44 in

25   combination with the parametric speaker 42.

The use of a directional light beam 78 in combination with directional sound 82 creates many benefits previously unknown within the voice projection industry. For example, a focused beam of

30   light provides a silent scanning device for target identification. The user simply activates the light source 44 and moves the bullhorn 10 until the desired recipient (or target 43) is illuminated with a spot of light. This silent mode of target detection provides

35   an advantage to the user because it allows for the element of surprise. The user knows he has accurate recipient identification because the light 78 and

sound beams 82 are in substantial alignment. Therefore, the user is able to confirm that the identified individual is probably receiving the audio transmission from the bullhorn.

5 Many forms of light source 44 are well suited for this duality aspect of sound and light. For example, the directional light source 44 may be a laser, a light emitting diode, a flash tube with parabolic reflector, or any other form of directional light  
10 source which can provide a narrow light beam 78. Where full illumination of the individual or group intended to receive the message, a spotlight having intense illumination may be used. The adjustable focusing device (or focal length adjustor 41) may also  
15 be added to provide depth adjustment for the focal point of the beam.

The primary component of the present invention is the parametric speaker 42 which is coupled to an emitter end of the housing 26 for indirectly  
20 generating at least one new sonic frequency from at least two ultrasonic frequencies of different value. The principles and structure enabling generation of this parametric or acoustical heterodyne effect have been set forth in previous applications of the present  
25 inventor, including serial number 08/744,114. In addition, the general theory of difference wave generation between two ultrasonic frequencies has been well documented within the prior art. The present  
inventor has advanced the theory to a level of  
30 commercial application with significant improvements which have increased amplitude output and focused directionality.

As illustrated in Figure 3, the parametric speaker 42 includes a typical circuit 46 in which a  
35 modulator 50 is coupled to an ultrasonic frequency generator 54 and a sonic frequency generator 58. Amplitude modulation operates to produce at least two

ultrasonic frequencies 62 of different value, such that the modulated output embodies a new sonic signal which is decoupled when emitted within a nonlinear medium such as air. In this case, using either an  
5 upper or lower sideband, a new sonic signal is generated in the air, equal to 5 kHz, based on the difference of the base carrier frequency of 50 kHz and 45 kHz or 55 kHz sideband signals. This new sonic output is extremely directional in view of the high  
10 frequency of the carrier in the ultrasonic range. This enables the user to aim the bullhorn 10 at a distant target 43, engage the parametric speaker 42 and emit the 5 kHz sonic compression wave at the target.

15 In basic form, the parametric speaker 42 comprises an ultrasonic frequency generator 54 for providing a base or carrier frequency which is identified as  $f_1$ . This frequency is typically in a range of 40 kHz to 100 kHz, well above the audio range  
20 of 20 to 20,000 Hz. Therefore, the base frequency is not detectable to the human user.

Essentially, the ultrasonic base frequency develops audio output by combining in air with a second ultrasonic frequency whose value differs from  
25 the base frequency by a frequency range within audio bandwidth. This is accomplished by use of a sonic frequency generator 58 programmed to supply the desired sonic signal. This may be a preprogrammed computer chip which includes various messages or  
30 direct voice amplification useful in voice projection. Direct voice amplification responds to sonic signals that are generated at the bullhorn and detected by the microphone 34. For example, the user could speak into the microphone 34 and have the audio signals entered  
35 into the sonic frequency generator 58.

In each instance, the sonic output is fed to the modulator 50 which modulates the sonic signal with the

ultrasonic base frequency to produce at least two frequencies,  $f_1$  and  $f_2$ , representing two ultrasonic frequencies. For example, if  $f_1$  equals 50 kHz and the sonic signal is 5 kHz, the resulting frequencies include the base frequency 50 kHz and sideband ultrasonic frequencies 45 kHz and 55 kHz, comprising the sum of the modulated frequencies.

Figures 3 also identifies an ultrasonic emitter component 66 of the parametric speaker 42. This component 66 comprises at least one ultrasonic frequency emitter 70 coupled to the modulator 50 and aligned for transmission with the directional orientation of the housing 26. The emitter 70 may be any transducer or other means for generating ultrasonic frequencies in accordance with parametric technology. The specific transducers 70 (or emitters) shown in this embodiment comprise a set of bimorph transducers which form a perimeter around the outside of the horn emitter end 74. The perimeter of Figure 3 is configured in a circular shape, but may be in other ring shapes such as a rectangular shape 68. Any ultrasonic emitter may be used which meets the space limitations inherent in the bullhorn configuration. The actual number of transducers 70 will depend on the physical dimensions of the horn 18 or emitter 70 structure.

In the present embodiment, the transducers 70 are positioned around emitter end 74 of the bullhorn 10 to form a parametric array. It has been discovered that a ring of transducers 70 is surprisingly effective in generating a highly directional, high amplitude, narrow beam of sonic output. Indeed, the absence of transducers within the ring appears to have little effect on the actual output of the parametric array. The sound pressure level (SPL) attenuation as a function of distance is virtually the same for a ring of transducers, as for a continuous array of

transducers disposed across the full surface of the horn 18 end. This discovery enables successful implementation of the present invention because the ring of transducers 70 is ideal for a circumferential configuration around a barrel or other bullhorn body. It also enables adaptation of the bullhorn with other features such as the fixation of the light source 44 within the horn opening.

A further entertaining feature of the dual sound and light aspect of the present invention occurs when the light source 44 includes a light modulator 86 for modulating transmission of the light source 44 with sonic input from the parametric speaker 42. A conventional modulation circuit coupled between the parametric speaker 42 and the voltage source for the light enables the light intensity to vary with variations in the sonic output. For example, light intensity may track amplitude of the sonic output, and thereby provide a visual component to the broadcast speech of the bullhorn.

This combination of sound and light transmission provides a surprising feature of being able to "throw" or project the users voice from a distant object. For example, a policeman in pursuit of a suspect may give a warning message to surrender to custody. By directing the light at a distant wall, a proper reflective surface can be identified. The voice message can then be activated, giving the suspect a false sense of police location from the reflected surface. The suspect is then disoriented as to the direction of pursuit of the police. Because the suspect will likely move away from the source of the voice, the police can often predict the direction of flight and can position other officers in that path.

This same feature is useful in entertainment. A ventriloquist may speak into a lapel microphone which is activated by his foot during a dialog. This "dummy"

voice would be projected onto a distant face representing his partner. By alternately activating the bullhorn or voice projection device with the foot pedal, the single ventriloquist can create actual  
5 voice separation between two locations. For interesting effect, the light may be projected with the voice. By modulating the light with voice output as is discussed hereafter, an interesting "talking light" phenomenon is achieved.

10 As indicated above, the device may include an integrated computer chip having prerecorded sonic messages which supply instruction, warning or other content which is of a recurring need. This chip is responsive to the control pad 38 (or selector) for  
15 preselecting one of the prerecorded messages for transmission from the parametric speaker 42. The prerecorded message is useful for many applications such as protecting the identify of the user by masking his voice, or simply substituting another voice from a  
20 different individual. Use of the pre-recorded message also avoids a need for the user to personally give the message and thereby compromise his location. With the prerecorded message, the user need say nothing. The parametric array projects the recorded voice in a  
25 directional manner, enabling the user to target a select place or individual for private transmission of the message. The absence of sound other than along the narrow beam of parametric sound, prevents others from hearing what is projected.

30 This selective control of the sound and light circuits are collectively manipulated by the trigger 40 which is coupled to the housing 26. In this embodiment, the three-position trigger enables the use of the rest position 40A for when the bullhorn 10 is  
35 not in use, the activation of the light source 44 at the intermediate position 40B, and the engaged position 40C available for subsequently activating the

parametric speaker 42. This sequence facilitates visual identification of the target based on a spot of light with the intermediate trigger position 40B. The engaged trigger position 40C can then be selected, giving the sonic signal which conveys the desired message.

Figure 4 illustrates a basic system which includes an oscillator or digital ultrasonic wave source 90 for providing a base or carrier wave 94. This wave 94 is generally referred to as a first ultrasonic wave or primary wave. An amplitude modulating component 98 is coupled to the output of the ultrasonic wave source (or generator) 90 and receives the base frequency or carrier wave 94 for mixing with a sonic or subsonic input signal 102. The sonic or subsonic signal 102 may be supplied in either analog or digital form, and could be sound from any conventional signal source 106. If the input signal 102 includes upper and lower sidebands, a filter component may be included in the modulator to yield a single sideband output on the modulated carrier frequency for selected bandwidths.

The emitter drum transducer is shown as item 110, which is caused to emit the ultrasonic frequencies  $f_1$  and  $f_2$  as a new wave form propagated at the face of a thin film transducer 114. This new wave form interacts within the nonlinear medium of air to generate the difference frequency 120, as a new sonic or subsonic wave. The ability to have large quantities of emitter elements formed in an emitter disk is particularly well suited for generation of a uniform wave front which can propagate quality audio output and meaningful volumes.

The present invention is able to function as described because the compression waves corresponding to  $f_1$  and  $f_2$  interfere in air according to the principles of acoustical heterodyning. Acoustical

heterodyning is somewhat of a mechanical counterpart to the electrical heterodyning effect which takes place in a non-linear circuit. For example, amplitude modulation in an electrical circuit is a heterodyning process. The heterodyne process itself is simply the creation of two new waves. The new waves are the sum and the difference of two fundamental waves.

In acoustical heterodyning, the new waves equaling the sum and difference of the fundamental waves are observed to occur when at least two ultrasonic compression waves interact or interfere in air. The preferred transmission medium of the present invention is air because it is a highly compressible medium that responds nonlinearly under different conditions. This nonlinearity of air enables the heterodyning process to take place, decoupling the difference signal from the ultrasonic output. However, it should be remembered that any compressible fluid can function as the transmission medium if desired.

Whereas successful generation of a parametric difference wave in the prior art appears to have had only nominal volume, the present configuration generates full sound. While a single transducer carrying the AM modulated base frequency was able to project sound at considerable distances and impressive volume levels, the combination of a plurality of co-linear signals significantly increased the volume. When directed at a wall or other reflective surface, the volume was so substantial and directional that it reflected as if the wall were the very source of the sound generation.

An important feature of the present invention is that the base frequency and single or double sidebands are propagated from the same transducer face. Therefore the component waves are perfectly collimated. Furthermore, phase alignment is at



maximum, providing the highest level of interference possible between two different ultrasonic frequencies. With maximum interference insured between these waves, one achieves the greatest energy transfer to the air molecules, which effectively become the "speaker" radiating element in a parametric speaker. Accordingly, the inventor believes the enhancement of these factors within a thin film, ultrasonic emitter array as provided in the present invention have developed a surprising increase in volume to the audio output signal.

These various structural components enable practice of a novel method for supplying directional sound from a parametric array within a bullhorn or pointer by indirectly generating at least one new sonic frequency which is a difference of at least two interacting ultrasonic frequencies. The basic method comprises the steps of a) emitting from the bullhorn at least one first ultrasonic frequency along a direction which is in alignment with a directional orientation of the bullhorn; b) emitting from the bullhorn a second ultrasonic frequency in a manner which causes the second ultrasonic frequency to interact with the first ultrasonic frequency to generate the new sonic frequency, wherein the second ultrasonic frequency has a frequency equal to the at least one first ultrasonic frequency plus at least one sideband corresponding to the at least one new sonic frequency; and c) directing the bullhorn at a target and operating the bullhorn to propagate toward the target the at least one new sonic frequency.

It is to be understood that the above-described embodiments are only illustrative of the application of the principles of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present invention.

16

The appended claims are intended to cover such modifications and arrangements.

CLAIMS

What is claimed is:

1. A sound projection device for use in speaking to one or more specific persons in a large group of people on a selective basis, said device comprising:
  - a housing including a directional aspect for aiming the housing at a target area;
  - gripping means coupled to the housing to enable the device to be held in a user's hand;
  - parametric speaker means coupled to a front end of the housing for indirectly generating at least one new sonic frequency from at least two ultrasonic frequencies of different value, said speaker means comprising:
    - i) an ultrasonic frequency generator;
    - ii) a sonic frequency generator;
    - iii) modulating means coupled to the ultrasonic frequency generator and the sonic frequency generator for producing the at least two ultrasonic frequencies of different value; and
    - iv) at least one ultrasonic frequency emitter coupled to the modulating means and aligned for transmission with the directional orientation of the housing for propagating the at least two ultrasonic frequencies and concurrently generating the new sonic frequency with a directional sound transmission orientation toward the target area;
  - luminating means coupled to the housing and having a directional orientation substantially aligned with the directional aspect of the housing; and
  - activating means coupled to the housing for selectively activating the luminating means to identify the target area and the parametric

speaker means to propagate the new sonic frequency toward the target area.

2. The device as defined in claim 1 wherein the  
5 modulating means comprises an amplitude modulating device which modulates an ultrasonic frequency signal with a sonic signal to thereby generate the at least two ultrasonic frequencies, said modulating means including means for generating the at least one new  
10 sonic frequency to be transmitted to the target area.

3. The device as defined in claim 2 wherein the modulating means includes means for generating a single sideband signal embodying the at least two  
15 ultrasonic frequencies for optimizing amplitude and transmission of a sonic frequency of predetermined bandwidth.

4. The device as defined in claim 1, wherein the  
20 sonic frequency generator includes an integrated computer chip having prerecorded sonic signals comprising prerecorded messages.

5. The device as defined in claim 4, further  
25 comprising means for supplying a plurality of different prerecorded sonic signals, and including selector means for preselecting one of the prerecorded signals for transmission from the parametric speaker.

30 6. The device as defined in claim 4, wherein the prerecorded messages are selected from the group of human voice messages consisting of a police warning to a suspect, a fireman message to a person in jeopardy, a military message to a combatant, a security guard  
35 message to a possible intruder, a confidential message to a selected individual within a group of people, a

prompting message to a performer, and a technician message to a member of a stage crew.

7. The device as defined in claim 1, further  
5 comprising means for recording additional sounds to a signal storage means coupled to the sonic frequency generator.
8. The device as defined in claim 1, wherein the  
10 illuminating means comprises a directional light source positioned to emit light along the directional orientation of the device to enable visual target identification.
- 15 9. The device as defined in claim 8, wherein the directional light source comprises a laser.
10. The device as defined in claim 8, wherein the  
20 directional light source comprises a light emitting diode.
11. The device as defined in claim 8, wherein the directional light source comprises a flash tube.
- 25 12. The device as defined in claim 8, further comprising light modulating means for modulating transmission of the light source with sonic input from the parametric speaker.
- 30 13. The device as defined in claim 12, wherein the light modulating means responds to deferring frequency values of the sonic input to create correlated light and sound concurrently emitted from the toy bullhorn.
- 35 14. The device as defined in claim 12, wherein the light modulating means includes means for correlating sonic input comprising speech with output of the light

source, thereby creating an impression of a talking light.

5 15. The device as defined in claim 14, further comprising microphone means coupled to the sonic frequency generator for enabling direct transmission of a sonic frequency comprising a human voice to the target area.

10 16. The device as defined in claim 8, further comprising focusing means operable with respect to the light source for increasing light intensity at a desired distance and location.

15 17. The device as defined in claim 1 wherein the housing comprises a configuration selected from the group consisting of a bullhorn, a flashlight, and a megaphone.

20 18. The device as defined in claim 1 wherein the at least one ultrasonic frequency emitter is comprised of an ultrasonic acoustical transducer.

25 19. The device as defined in claim 1, further comprising a microphone and associated audio amplification circuitry coupled to the housing for detecting sound, said audio amplification circuitry being coupled to the modulating means for providing the detected sound as a new sonic frequency to enable  
30 transmission of speech as the new sonic frequency.

20. The device as defined in claim 1 wherein the device further comprises an ultrasonic frequency signal generator which transmits the first ultrasonic  
35 frequency to the modulating means and wherein the modulating means includes input means for mixing at least one new sonic frequency with the first

ultrasonic frequency as upper and lower sidebands for transmitting low frequencies within an audio range.

21. A method for supplying directional sound and  
5 light from a voice projection device by indirectly generating at least one new sonic frequency which is a difference of at least two interacting ultrasonic frequencies, the method comprising the steps of:

a) emitting from the projection device at least  
10 one first ultrasonic frequency along a direction which is in alignment with a directional orientation of the projection device;

b) emitting from the projection device a second  
ultrasonic frequency by means which cause the second  
15 ultrasonic frequency to interact with the first ultrasonic frequency to generate the new sonic frequency, wherein the second ultrasonic frequency has a frequency equal to the at least one first ultrasonic frequency plus at least one sideband corresponding to  
20 the at least one new sonic frequency;

c) directing a light from the projection device along the directional orientation toward a common target area with the new sonic frequency; and

d) propagating a desired message as the new sonic  
25 frequency.

22. A method as defined in claim 21, further comprising the step of generating the at least one new sonic frequency as a sonic output corresponding to a  
30 human voice message.

23. The method as defined in claim 21, further comprising the step of electronically amplifying speech of a user of the device and modulating the  
35 speech as part of the second ultrasonic frequency to thereby transmit the speech to the target in a directionally isolated manner.

24. The method as defined in claim 21, further comprising the step of recording the at least one new sonic frequency on a memory chip and transmitting the  
5 at least one new sonic frequency from the memory chip as part of the second ultrasonic frequency.

25. The method as defined in claim 21, further comprising the step of emitting a directional light  
10 from the device along the directional orientation to identify the target area visually, thereby enabling isolation of the target for transmitting the at least one new sonic frequency.

15 26. The method as defined in claim 25, further comprising the step of modulating the light emitted from the device with the at least one new sonic frequency.

20 27. A method of simulating sound with a light source in accordance with the method defined in claim 25, comprising the additional step of modulating the light emitted from the device with sonic input, thereby creating a variable light transmission which  
25 correlates with the sonic input.

28. The method as defined in claim 21, further comprising the step of transmitting a predetermined voice message to a designated target in an isolated  
30 manner so that the message is heard only in direct proximity to the target area.

29. A speech projection device having a directional orientation for emitting both light and sound in a  
35 narrow beam with selective focus toward another person at a distance by indirectly propagating from the distant person at least one new sonic frequency as a



by-product of emitting at least two ultrasonic frequencies from an ultrasonic frequency emitter, said device comprised of:

5 a housing having a light transmitting opening and an audio emitting perimeter positioned at an emitting end of the housing, said light transmitting opening and the audio emitting perimeter having a common directional orientation along a common transmission axis;

10 an ultrasonic frequency signal source contained within the housing for providing a first ultrasonic frequency signal;

supply means coupled to the housing for supplying an electrical signal corresponding to the at least one  
15 new sonic frequency;

modulating means contained within the housing and coupled to the ultrasonic frequency signal generator and supply means for combining the first ultrasonic frequency signal with the electrical signal  
20 corresponding to the at least one new sonic frequency to thereby generate a second ultrasonic frequency signal;

a plurality of ultrasonic frequency emitters positioned at the audio emitting perimeter of the  
25 housing which are coupled to an output of the modulating means for (i) propagating both the first and second ultrasonic frequency signals, and (ii) generating the at least one new sonic frequency wave train as a by-product of interference between the  
30 first and second ultrasonic frequency signals; and

a light source positioned within the light transmitting opening and having a directional means for focusing light toward a selected recipient.

35 30. A device as defined in claim 29, wherein the audio emitting perimeter is configured in a circular

shape, said ultrasonic frequency emitters being disposed in a circular pattern within the perimeter.

5 31. A device as defined in claim 29, wherein the audio emitting perimeter is configured in a rectangular shape, said ultrasonic frequency emitters being disposed in a linear, rectangular pattern within the perimeter.

10 32. A device as defined in claim 29, wherein the audio emitting perimeter is configured in a rectangular shape, said ultrasonic frequency emitters being disposed in a rectangular pattern within two opposing sides of the rectangular shape.

15 33. A device as defined in claim 29, wherein the supply means comprises a microphone positioned at an opposing end of the housing from the emitting perimeter to be responsive to audio input from a user.

20 34. A sound projection device comprising:  
i) an ultrasonic frequency generator;  
ii) a sonic or subsonic frequency generator for generating a new frequency;  
25 iii) modulating means coupled to the ultrasonic frequency generator and the sonic or subsonic frequency generator for producing the at least two ultrasonic frequencies of different value based on the new frequency; and  
30 iv) at least one ultrasonic frequency emitter having a ring configuration with an interior open section and being coupled to the modulating means for propagating the at least two ultrasonic frequencies and concurrently  
35 generating the new frequency with a directional sound transmission orientation toward a target area.

35. The device as defined in claim 1 wherein the modulating means comprises an amplitude modulating device which modulates an ultrasonic frequency signal with a sonic signal to thereby generate the at least two ultrasonic frequencies, said modulating means including means for generating the at least one new sonic frequency to be transmitted to the target area.

36. A method for supplying directional sound from a voice projection device by indirectly generating at least one new sonic or subsonic frequency which is a difference of at least two interacting ultrasonic frequencies, the method comprising the steps of:

a) configuring an ultrasonic emitter device in a ring configuration having an open, interior section;

b) emitting from the emitter device at least one first ultrasonic frequency and a second ultrasonic frequency by means which cause the second ultrasonic frequency to interact with the first ultrasonic frequency to generate the new frequency, wherein the second ultrasonic frequency has a frequency equal to the at least one first ultrasonic frequency plus at least one sideband corresponding to the at least one new frequency.

37. A sound projection device having a directional orientation for emitting sound in a narrow beam with selective focus toward another person at a distance by indirectly propagating from the distant person at least one new sonic or subsonic frequency as a by-product of emitting at least two ultrasonic frequencies from an ultrasonic frequency emitter, said device comprised of:

a support housing having an opening and an audio emitting perimeter positioned at the housing;

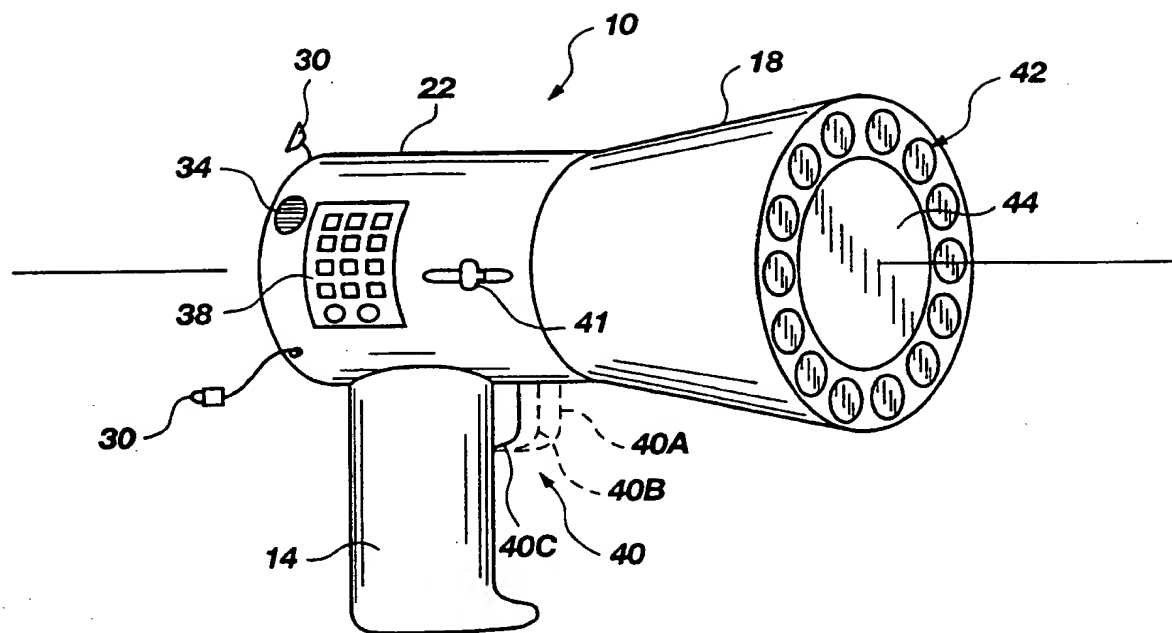
an ultrasonic frequency signal source for  
providing a first ultrasonic frequency signal;

an electrical signal source for supplying an  
electrical signal corresponding to the at least one  
5 new sonic or subsonic frequency;

modulating means coupled to the ultrasonic  
frequency signal source and supply means for combining  
the first ultrasonic frequency signal with the  
electrical signal corresponding to the at least one  
10 new sonic or subsonic frequency to thereby generate at  
least one second ultrasonic frequency signal;

a plurality of ultrasonic frequency emitters  
positioned in a ring configuration at an emitting  
perimeter of the support housing surrounding an open  
15 interior section, said emitters being coupled to an  
output of the modulating means for (i) propagating  
both the first and second ultrasonic frequency  
signals, and (ii) generating the at least one new  
sonic frequency wave train as a by-product of  
20 interference between the first and second ultrasonic  
frequency signal.

1/4

**Fig. 1**

2/4

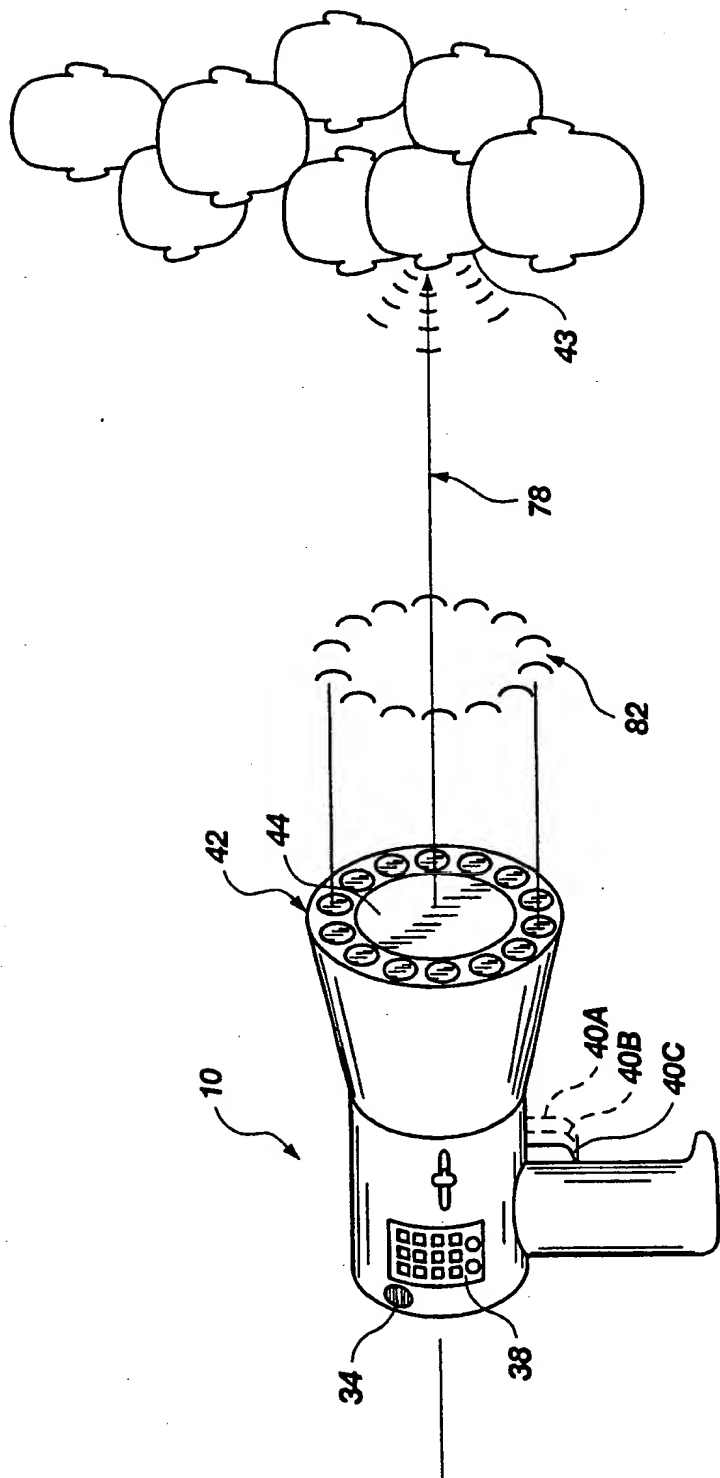


Fig. 2

3/4

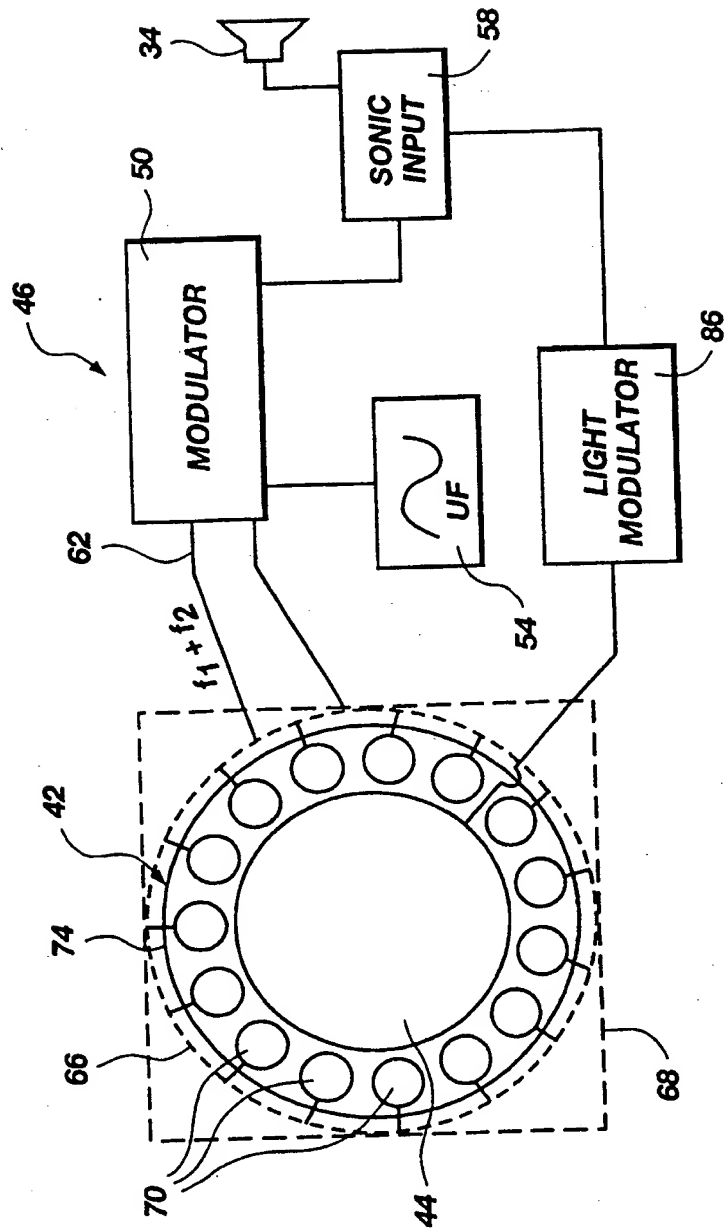
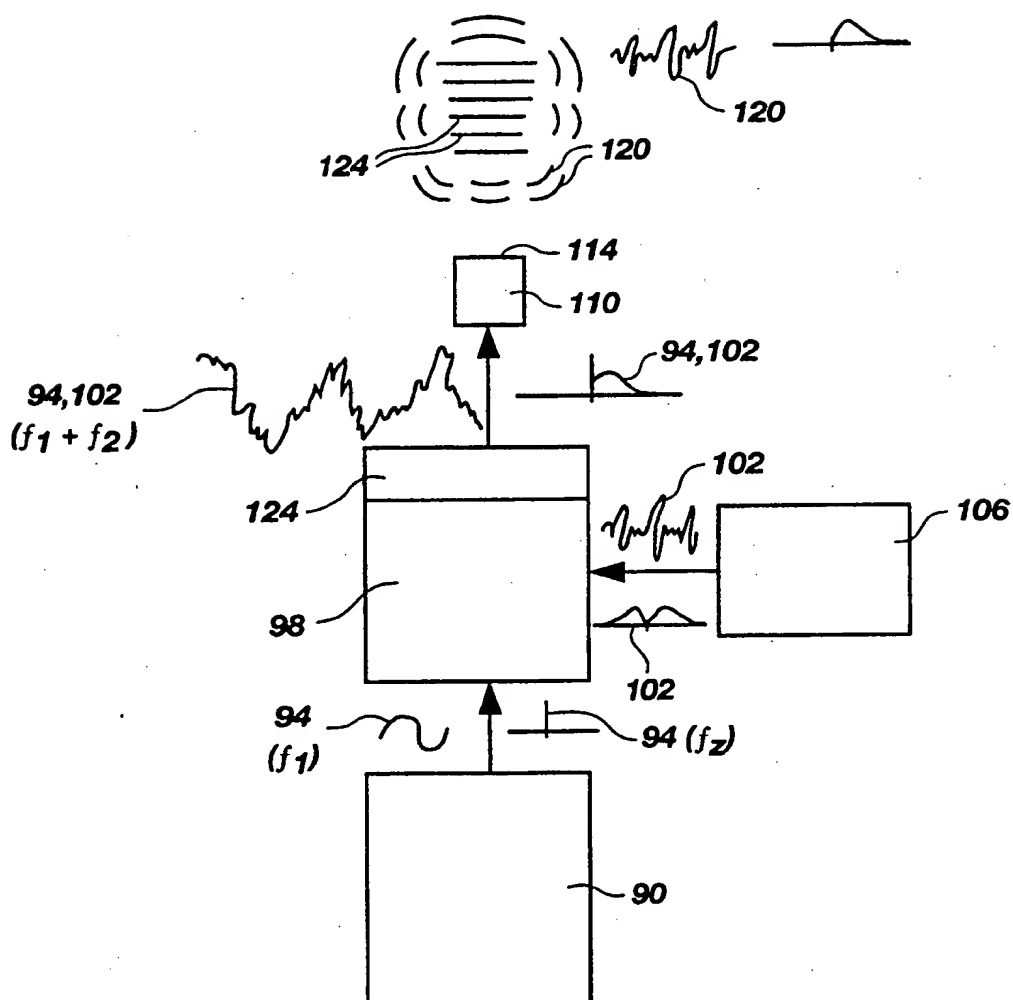


Fig. 3

4/4

**Fig. 4**



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/08729

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H04R 2500

US CL : 381/75

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 381/75, 82, 87; 29/169.5

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

search terms: bullhorn, parametric speaker, illumination, light

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2-265400 A (Minamiyama) 30 October 1990, see Fig. 4a.	1-37
-----		-----
Y		1-37
Y	US 5,181,301 A (Wheeler) 26 January 1993, see abstract.	1-37

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

18 AUGUST 1998

Date of mailing of the international search report

08 OCT 1998

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

SINH TRAN

Telephone No. (703) 308-4811